CROP ROTATION

advantageous for sustainable farming in

WESTERN CAPE

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A lot has been written and said about the importance and advantages of practising crop rotations on farms. Some of the main issues that have been extensively researched in long-term crop rotation trials being conducted by the Department of Agriculture: Western Cape, are considered below.

Monoculture

Monoculture is the practice of growing the same crop on the same land from one growing season to the next. Wheat monocultures were commonly practiced on many farms in the Western Cape (particularly in the Swartland) mainly because such wheat monocultures maximised total farm income. The disadvantages of monocultures include more intensive production practices such as increased tillage, fertilisation and pest (disease, insects and weeds) control inputs.

Input costs are therefore increased which, together with the current highly variable and often low “farm gate” price of wheat, result in greater financial risk to the producer. Another disadvantage of monoculture is that the production and quality of wheat is often lower than for wheat that is grown in rotation with an alternative crop or legume pasture. The lower yield and quality of wheat in monoculture are a result of increased presence of disease and competition from weeds. This further increases the financial risk to the producer.

Perhaps the greatest disadvantage of wheat monoculture is the major herbicide resistance problems that have emerged in the last decade. The development of herbicide resistant grass weeds (mainly ryegrass, but also “predikanluis”) have ensured that wheat production based on monocultures will not be sustainable.

As a result of these problems mentioned above, grain producers can not ignore (and in most cases have not ignored) the benefits of crop rotation even though total farm income may decline.

Crop rotation

Crop rotation is the practice of growing a sequence of different crops (and pastures) on the same land from one growing season to the next. Each production enterprise (farming unit) has different environmental (soil and climate) and financial constraints and opportunities that will dictate the sequence of crops that can be grown on a particular land. The choice of crop sequence for a particular land will also be influenced by the management ability of the producer and the crop and/or crop/pasture production systems planned for the whole farm.

Crop rotation has been shown to increase yields, increase returns on capital investment and provide a more sustainable production system when compared to traditional monocultures in all parts of the world and in the cereal cropping areas of the Western Cape.

Benefits of crop rotation

Wheat yields

Results from a long-term experiment in the Swartland region of the Western Cape clearly show the yield benefit for wheat production when alternative crops or pastures are included in the production system. For example:

- The yield of wheat following canola in a four-year rotation with three years of wheat and one year of canola was increased by 20% compared to wheat production in a wheat monoculture. There was also an increase in wheat production in the (wheat/wheat/wheat/canola system) relative to a wheat monoculture where wheat is grown in the second year (11% increase) and even the third year (8% increase) after canola.

- Including a crop such as lupin into the rotation together with wheat and canola shows even greater benefits to wheat production when wheat follows canola in the cropping sequence.

- There was a 35% yield benefit for wheat where wheat follows a legume crop such as lupin or a legume pasture such as medic, when compared to a wheat monoculture.

- At farm scale where half the cultivated land is planted to wheat and the other half is planted to canola and lupins, or to annual legume pasture, the yield increases of wheat in rotation imply that about 30% more wheat would be produced on that half of the cultivated area than would have been produced if that half had been planted in a wheat monoculture.

The largest effects that crops grown in one year have on the subsequent crops are usually those on soil-borne pests and diseases, on nutrition and on opportunities to control weeds.

Pest and disease control

Local research has shown the positive effects of rotation on reducing crown rot ("kronvrot") in wheat. A single non-cereal crop (such as lupin) inserted in a sequence of wheat crops can prevent measurable damage by take-all ("vrotkootje") to the next wheat crop.

Benefits for soil organic nitrogen

In addition to breaking disease cycles, the beneficial effects of legumes in cereal grain rotations are to reduce N inputs in the subsequent grain crop. Nitrogen supplied by legumes has been shown in certain circumstances to disperse through the soil profile and is more effectively retrieved by wheat compared with surface applied N fertilizer.

Medics and clovers have been shown to contribute to soil organic matter and provide 40 kg to 100 kg of nitrogen per hectare per year to the soil profile, up to 40% of which is available to the subsequent crop.

Weed control

Grass weeds may be effectively controlled in broad-leaved crops thus reducing costs and grass-weed competition and increasing yields in the subsequent grain crop. The inclusion of a crop such as canola, or legume pasture, into the rotation provides excellent opportunities to control the grass weeds (particularly annual ryegrass - Lolium spp) that are becoming a serious problem to cereal grain producers in the southern Cape and Swartland.

Continued on page 36
CROP ROTATION

Continued from page 36

By controlling the grass weeds one is also removing the host of soil borne cereal diseases such as root rot and crown rot that can have a massive negative effect on grain production. It has also been suggested that the root exudates of canola have a bio-fumigation effect that may suppress soil borne diseases harmful to cereals. In addition the removal of grass weeds removes the competition that the grass weeds will have for resources that the cereal crops require for optimal production.

Other important benefits of including crops such as canola (or legumes) into the rotation are:

- **Spreading financial risk on the farm.** Such benefits would obviously be a function of crop yields and the input and commodity pricing structures that vary from year to year. Detailed gross margin analyses of the long-term crop rotation trials in the Swartland and the southern Cape clearly show that, when compared to cereal-based cropping systems, the inclusion of crops such as canola and lupins, or legume pastures into the farming system, will maintain or improve the returns on total variable cost inputs of the farming enterprise.

- **Crop production efficiency can be improved due to the fact that a crop such as canola is usually planted and harvested earlier than cereal crops, so the use of planters and harvesters can be spread over a longer period if part of the farm is set aside for canola production.**

- **Unlike some cereal crops, crops such as canola and lupins can be grown either before or after any cereal crop and can therefore be planted at almost any stage of the cropping sequence.**

**Crop rotation systems of the Western Cape**

Each producer should plan the crop sequences for each land based on the planning of the whole farm production system (e.g. planning regarding the proportion of the farm under pastures and the number of hectares of cereal and oil and protein crops in a particular season), suitability of the soils (physical and chemical) and agronomic requirements for the crop. There are no recipes! As a guide, however, there are two main systems that are generally followed:

- Long rotations are where a land is usually planted to a perennial pasture such as lucerne for five to seven years followed by a cropping phase of five to seven years before lucerne is established again for a further five to seven years and so on.

- Short rotations are where a land is either continuously cropped using different crops in sequence from one year to the next, or the land is planted to an annual pasture such as medics and sub-clovers in annual or biannual rotation with wheat or other cereal crops.

Most producers in the southern Cape use long rotation systems although continuous cropping is practiced by some producers on lands with high potential (areas of higher, more reliable rainfall). Some lands (usually those not suited to lucerne production) are also allocated to short rotation crop/annual legume pasture systems.

Short-rotation crop/annual legume pasture and continuous cropping systems are commonly practiced in the Swartland.

**Have Western Cape producers adopted crop rotation as a standard agricultural practice?**

To understand the current levels of adoption of crop rotation in the cropping systems of the Western Cape, one must not only examine the local soil and climatic potential of a farm, but one must also understand the external factors that have influenced the production system as a whole.

**External factors** Prior to the 1990’s, agricultural commodity markets were strictly controlled by some form of government legislation. Product prices were not subject to normal market forces and were often abnormally high. Such control extended to the quality requirements of the grain and grain products and costs of producing meal and flour, as well as the price to the consumer.

Price control encouraged practices that were essentially non-sustainable, both economically (in a deregulated market) and environmentally. Areas with marginal production potential were brought into production, mono-cropping was widely practiced and, as farms were relatively small, there was a tendency to over-capitalise on farm machinery and equipment.

High inputs were used in an attempt to achieve maximum production. In the Western Cape traditional crop rotation systems were phased out in favour of wheat production, resulting in large areas under wheat monocultures.

As a result of deregulation and changes in marketing and government policies from the 1990’s, producers were exposed to the world markets that governed the wheat price. Producers were also exposed to increasing costs of imported fertilisers, chemicals and oil and capital items such as farm machinery and implements, as well as a “transport differential” on the grain price, all of which inflated fixed and variable production costs. These changes had a dramatic effect on wheat production in the country.

What has all this got to do with crop rotation? The major economic upheaval on grain farming enterprises that resulted from the deregulated markets required that producers re-think their production systems and spread risk. Lands with low wheat production potential were either abandoned or planted to alternative, better adapted, crops or pastures.

By the middle 2000’s the area planted to wheat in South Africa had been reduced by approximately 60% when compared to the 1990’s (Graph 1). The areas allocated to wheat production in the Western Cape also decreased dramatically. In 2009, only 315 000 ha was planted to wheat compared to over 800 000 ha in the 1980’s. It was therefore necessary to design cropping systems to allow for the incorporation of alternative crops and pastures. Crop rotation is a natural outcome of this process.

**The current situation**

A generalised picture of the proportions of different crops and pastures that are presently cultivated on farms in the two major production regions of the Western Cape (the Swartland and the Southern Cape), is presented in Table 1.

Clearly producers in the southern Cape region have gone a long way to maximising the potential to diversify their production systems when compared to the Swartland. There are good reasons for this. The main reason is that, while the range in annual rainfall across the different farming areas of the southern Cape is similar to the range in annual rainfall across the farming areas of the Swartland, rainfall distribution differs between the two regions.

In the southern Cape a proportion of the annual rainfall occurs in the summer months with that proportion increasing from west (25% summer rain) to east (40% summer rain). Crop-pesture rotations are therefore more common in the southern Cape than in the Swartland because of the higher risk of crop failure due to a lower and less reliable rainfall during the growing season.

Another reason is that, because of the summer rainfall, lucerne is well adapted to the
Table 1: Estimated proportions (%) of total cultivated areas of the Southern Cape and Swartland regions that are planted to different cash crops and legume pasture or forage crops — excluding old lands. (Data from Sasol (2003) and Department of Agriculture: Western Cape — 1 000 point assessments (2005)).

<table>
<thead>
<tr>
<th>Crop/pasture</th>
<th>S Cape</th>
<th>Swartland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>22.3</td>
<td>50.1</td>
</tr>
<tr>
<td>Barley (maize)</td>
<td>12.5</td>
<td>0</td>
</tr>
<tr>
<td>Canola</td>
<td>5.3</td>
<td>3.5</td>
</tr>
<tr>
<td>Lupine</td>
<td>0.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Lucerne</td>
<td>36.1</td>
<td>0</td>
</tr>
<tr>
<td>Medics/clovers</td>
<td>0.1</td>
<td>11.2</td>
</tr>
<tr>
<td>Cereal/hay/pasture</td>
<td>14.9</td>
<td>26.7</td>
</tr>
</tbody>
</table>

Graph 1: Total areas planted to wheat in South Africa: 1971 to 2005 (Source: Abstract of Agricultural Statistics 2006, Department of Agriculture, South Africa).

area and provides a stable, permanent, high-quality pasture. Lucerne is not adapted to the long, dry and hot summers of the Swartland region. Lucerne pastures help spread financial risk by providing a relatively stable, pasture-based sheep enterprise and by lowering whole farm input costs.

Considering the Southern Cape as a whole one can see that, of the area under cultivation and pasture/forage production, an estimated 22% is planted to wheat, 12.5% to barley and 5% to canola (Table 1), while 36% is planted to lucerne, 8% to medic and annual clovers and 15% to forage production. While some farms may have both lucerne and medic/annual clover pastures, most farms would have either lucerne or medic/clover.

The typical rotation would therefore be five or six years of lucerne followed by five or six years of crops with the majority of the cropped area in this phase being allocated to wheat and, to a lesser extent, barley — although this depends greatly on the area within the Southern Cape where a farm is located.

It seems from the above that most farms in the Southern Cape region are managed using some form of crop rotation. Management to increase areas under a specific crop would therefore require a decrease in the area planted to another crop or pasture. Short-term and long-term economic considerations, as well as biological and management advantages would help the producer make decisions on increasing or decreasing the area under specific crops and adjusting the crop or crop/pasture rotations on the farm.

However, since a large proportion of the cultivated area of the Southern Cape is planted to permanent pasture, adjusting areas planted to different crops would, at least in the short-term, be based on the area available for annual cropping.

Considering the Swartland as a whole, the average area of land allocated to wheat is approximately 56% of the total area under cultivation (including pastures) on a farm. Annual legume pastures (medics and clovers) and forage production (hay, pasture and feed grain from oats or “koros”) make up the next highest proportion (about 38%).

Alternative crops such as canola (3.5%) and sweet lupin (2.4%) make up a very small proportion of the area under crops and pasture/forage crops in any one year. So, on average, producers are practicing some form of rotation although the rotation is based mainly on cereal grain and cereal fodder crops. Since the cropping crop/livestock production systems of the Swartland are based on short rotations producers have greater opportunity to adjust the areas under specific crops than do their Southern Cape counterparts.

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